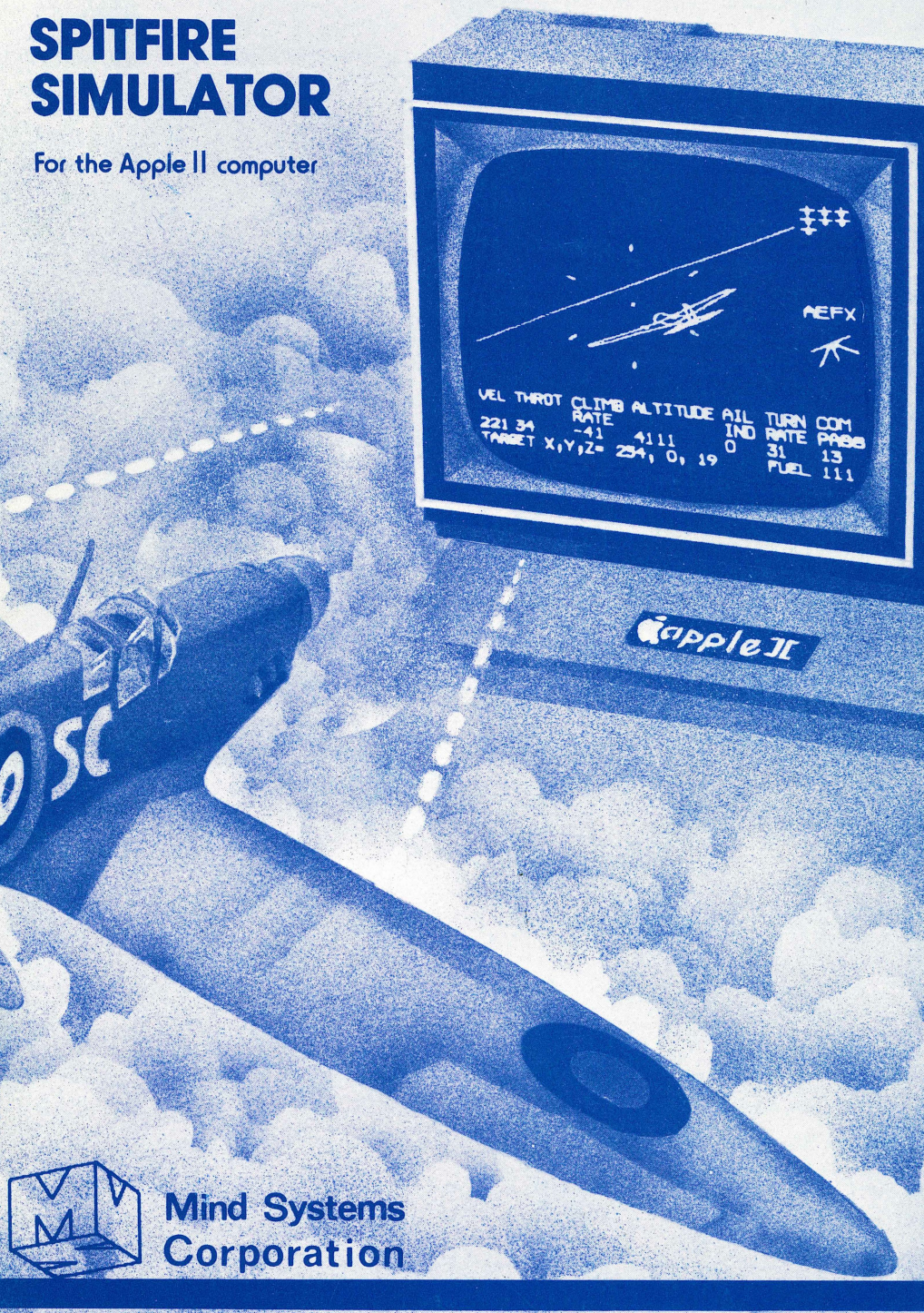
SPITFIRE SIMULATOR

For the Apple II computer



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SPITFIRE SIMULATOR
for the
Apple II Computer

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June 1982

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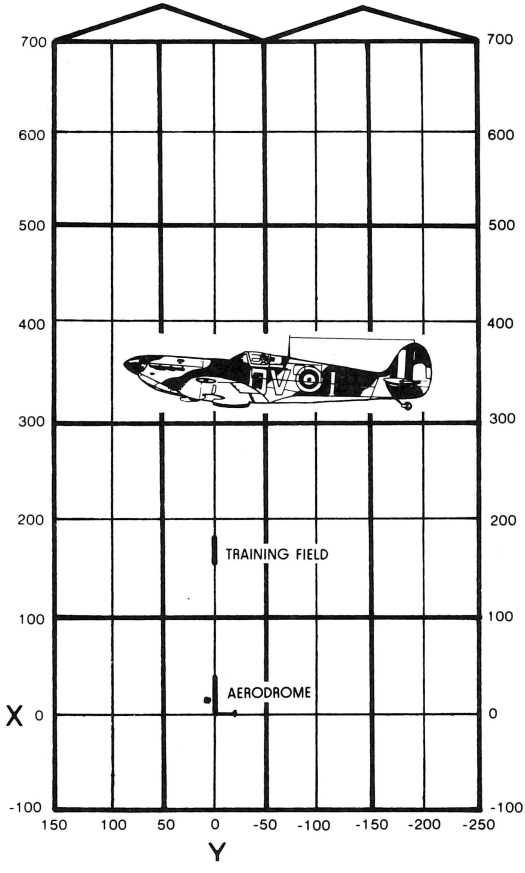
Figure 1

SPITFIRE SIMULATOR...



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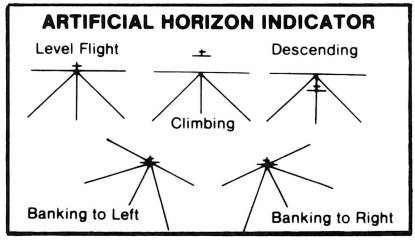

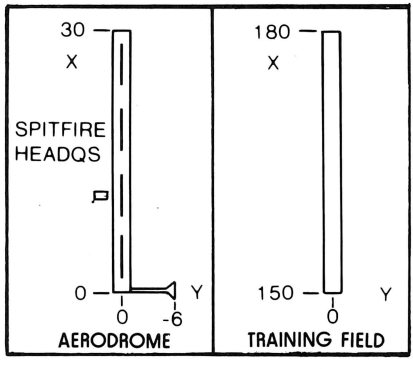

1. INTRODUCTION

Simulation is one of the most interesting and enjoyable applications of digital computers. Simply turn on the computer, boot an appropriate disk, and you can move into another time, another place, to have experiences which would be either difficult or impossible to have otherwise. Use your Apple II or II PLUS computer and SPITFIRE SIMULATOR to take a journey with us, back in time to another era. Try to imagine that you are actually there. You are about to fly the fast and nimble Spitfire.

The time is early 1941, and the place is England. The Battle of Britain is underway. German airplanes are invading the skies of England, and it is your mission to help rid the skies of their presence. They come from the North or from the South, from the East or from the West. Some fly high and some fly low; some are slow and some are fast. Your fuel capacity will limit your opportunity to pursue your targets, and you can maximize your fuel economy by judicious use of the throttle. A special bonus awaits you if you can return safely to your Aerodrome at the end of a mission.

Your airplane is a Supermarine Spitfire Mk 1, the first production version of an airplane which was destined to become one of the most famous fighter airplanes of all time. It has a 1030 hp Rolls-Royce Merlin II engine, and a maximum level-flight speed of 360 mph. The design was an outcome of the Supermarine seaplane racers which competed very successfully in the famous Schneider Cup races. The designer, Reginald Mitchell, died tragically of cancer before he saw how successful his Spitfire was going to be. Nonetheless, the Spitfire underwent continual subsequent development. In its final form, the Mk 24 of 1947, its maximum speed in level flight was greater than 450 mph.

If you have flown another digital-computer airplane simulator, our AIRSIM-1 Flight Simulator for example, then you should find it easy to fly SPITFIRE SIMULATOR. If this is your first experience with airplane simulators, you'll have to learn to fly. You will be able to fly SPITFIRE SIMULATOR because we'll give you flying lessons. SPITFIRE SIMULATOR is surprisingly easy to fly. We've included a Grid scene with a training field directly ahead of the Aerodrome so

that you can learn how to land, the most important and perhaps the most difficult maneuver to master. You'll also enjoy using the Grid scene for general practice and recreational flying. You'll find that SPITFIRE SIMULATOR is quite aerobatic, performing loops, rolls, etc. with great ease. The SPITFIRE is really a delight to fly. We've had countless hours of enjoyment simply flying around, doing aerobatics. We've crashed a lot too. It's a true wonder of the computer age that we live to fly again and again!

Flying around in the SPITFIRE is a lot of fun, but the name of the game with SPITFIRE SIMULATOR is pursuing targets. These targets are three dimensional. You can view them from all sides, and they change size and shape appropriately as you view them from different positions. The fighter planes of the 1940's carried gun cameras which made movie records of what transpired as the pilot pursued and shot at a target. The views presented by SPITFIRE SIMULATOR when pursuing a target are very similar to these gun-camera movies. If you are on target, within range, and lucky enough to hit a vital spot, your target will explode. You will then immediately be confronted by a new target to pursue. How many targets can you destroy on one mission? Can you make it home without crashing?

There are 8 different types of target aircraft for you to pursue as follows: Messerschmitt 109 fighter, Focke-Wulf 190 fighter, Stuka divebomber, Heinkel 111 bomber, Junker 52 trimotor transport, a Zepplin derigible, and two unidentified flying objects (UFO's). We used programming license with some of these targets. The Fw 190 appeared in 1944, but is our favorite German airplane. There were no Zepplins over England in 1941, but they are such a majestic sight that we wanted to see them fly again. As to the UFO's, well who knows? These targets, and the Aerodrome and Grid scenes, are stored on the disk. New targets are read off the disk automatically whenever a target is destroyed. Alternatively, any target or scene can be read off the disk at any time simply by pressing an appropriate number key, and - zip - almost immediately the new target or scene is there! When you're chasing a target, you won't be able to see any scenery except for the target and the horizon.

SPITFIRE SIMULATOR includes lots of options to make your flying more enjoyable. You can transport SPITFIRE around by using the CTRL-T command, an example of real computer magic, particularly useful for putting you quickly into position for pouncing on your prey. You can pause with CTRL-P, continue with CTRL-C, and alter aileron and elevator sensitivity with the "A" and "E" keys. There are many others, and they are all described in Section 2.

Before you go flying in your SPITFIRE, there are a few things we'd like to say which we believe you'll find helpful, especially if this is your first experience with a flight simulator. The biggest problem people encounter initially is a tendency to overcontrol the airplane. Beginning pilots should use only very small control inputs. Make a small control movement, and then hold it constant and see how the airplane responds. You can learn to perform aerobatic wonders with SPITFIRE SIMULATOR, but you must develop an intuitive feeling for how the airplane will respond to control inputs. We find it helpful to adopt the point of view that airplanes know a lot more about flying than we do, and that the best way to fly an airplane is to let it fly itself for the most part. The pilot changes the control inputs to change the way the airplane is flying itself. SPITFIRE SIMULATOR can fly itself very nicely. We often let it fly unattended for long periods of time - until it runs out of fuel!

Now it is time to go flying. Try to remember at all times to relax and enjoy yourself. Computer-airplane crashes don't hurt anything, so have a good time! We hope you'll get a lot of pleasure out of flying SPITFIRE SIMULATOR.

2. PROCEDURES, INSTRUMENTATION, AND CONTROLS

In this section we'll briefly outline how you use SPITFIRE SIMULATOR. We'll describe the hardware required, how to run the program, possible causes for problems, and the controls for the simulation. These controls are illustrated extensively in the subsequent sections. For convenience, a list of commands is on the last page of this manual.

Hardware Required

You'll need an Apple II or II Plus with 48K of RAM, one disk drive and game paddles or a joystick. We prefer a self-centering joystick. Also required is Applesoft in ROM, or its equivalent in RAM if you are using a RAM card in slot 0 without the Applesoft ROM on the main board. SPITFIRE SIMULATOR is all in machine code, but uses some subroutines in the Applesoft ROM/RAM space. A push button is required (either pb1 or pb2) to fire the machine guns.

Running the Program

To run SPITFIRE SIMULATOR, insert the SPITFIRE SIMULATOR disk in Disk-Drive No. 1, and boot the disk (PR#6 or 6 CTRL-P). You will hear the usual clattering noise while the disk drive looks for track 0, and then, very shortly, should see a title page with a copyright statement. The disk drive will clatter again, and start reading the SPITFIRE SIMULATOR program. After about 15 seconds the disk should stop, and you should see a second title page that says "CENTER CONTROLS AND PRESS ANY KEY". This refers to the two game paddles or the joystick. If using game paddles, position each paddle so that there is approximately equal paddle motion in either direction. You'll want to mark these paddle positions in some way. We use arrow-head shapes cut from removeable gummed labels. If using a joystick, this is an opportunity to adjust your trim settings. When ready, press any key, and the computer will record these reference positions as the zero-input control positions. You should then see scenery. A detailed description of how to proceed from there is presented in Section 3, A FIRST FLYING LESSON.

Possible Problems

It is exceedingly unlikely that SPITFIRE SIMULATOR has loaded incorrectly if it displays any scenery. If you have any difficulty getting the program to run, the most likely cause is a problem with the paddles or joystick. Bent pins or improper insertion of the 16-pin game-control connector are common sources of difficulty.

The following simple BASIC program is useful for checking the paddles or joystick:

```
10 PRINT PDL (0), PDL (1)
20 GO TO 10
30 END
```

If you RUN this program, you should see two streams of numbers which will vary smoothly between 0 and 255. The left-hand stream should vary as you move Paddle No. 0, and the right-hand stream should vary as you move Paddle No. 1. With your paddles or joystick centered, you should have readings near 128 for equal control effectiveness to either side of the central position. Erratic readings indicate paddle problems.

In the event you encounter problems you can't resolve, contact us. We're always willing to help.

Instrumentation - Beneath the windshield are:

VEL	Airplane velocity in mph.
THROT	Throttle setting in %.
CLIMB RATE	Climb-rate indicator in arbitrary units.
ALTITUDE	Altitude in feet. Indicates 6 feet when the wheels are on the ground.
AIL IND	Aileron/rudder-setting indicator, negative for left aileron/rudder, positive for right aileron/rudder. Useful for indicating when the ailerons are in the neutral position (AIL IND = 0).
TURN RATE	Turn rate in arbitrary units. Positive when the compass heading is increasing, and negative when the compass heading is decreasing.
COMPASS	Compass heading in degrees.
FUEL	Fuel remaining in arbitrary units. There is initially enough fuel for approximately 20 minutes at full throttle, and for longer times at reduced throttle.

Stall warning - This is a beeper which sounds when the airplane is stalled.

Above the compass there is an artificial horizon, an extremely

useful instrument indicating the attitude of the airplane. This instrument is described in Section 4, MORE-ADVANCED FLYING TECHNIQUES.

The space above the artificial horizon is used for indicating whether or not certain control options are active as described below, and for indicating how many targets have been destroyed on the current mission as described in Section 5, PURSUING TARGETS. Every time a target is destroyed, an additional small airplane symbol will be displayed in the upper portion of the space above the artificial horizon.

If there is a target present for you to pursue, the target position will be indicated along the bottom line of the screen. The X and Y coordinates are, respectively, the target distances to the north and to the west of the end of the Aerodrome where you start from after booting or initializing the program. The Z coordinate gives the target altitude. The X and Y coordinates are those corresponding to Figure 1.

Basic Airplane Controls and Options

Elevator

Game Paddle 0. Counterclockwise (decreasing readings) for up elevator, clockwise (increasing readings) for down elevator.

Aileron/rudder

Game Paddle 1. Counterclockwise (decreasing readings) to roll or turn to the left, clockwise (increasing readings to roll or turn to the right.

Throttle

The slash (/) key toggles the throttle setting. If the throttle setting is 0, then the / key will toggle the throttle to 100%. If the throttle setting is anything other than 0, the / key will toggle it to 0. The → key causes the throttle to increase gradually, and the ← key causes the throttle to decrease gradually. To halt the gradual change of throttle, press any other key.

Brake

The period (.) key activates the brakes when the airplane is on the ground. Pressing any other key releases the brakes.

Radar

The R key activates the radar. The radar view then replaces the scenery view. The airplane symbol in the center of the screen indicates where the airplane is. To restore the scenery press the S key.

Radar Scale

The + key increases the radar scale gradually, and the - key decreases the radar scale gradually. Pressing any

other key stops this scale-changing process. The @ key will initialize the radar scale. It is not necessary to press the SHIFT key when using either the + key or the @ key.

Machine Guns

The G key toggles the gunsight, 6 spots surrounding a central spot. Use either push button to fire the machine guns.

Aileron Sensitivity

The A key toggles the aileron sensitivity. The letter "A" will be displayed over the artificial horizon if the aileron sensitivity is high, and the "A" will be absent when the aileron sensitivity is normal.

Elevator Sensitivity

The E key toggles the elevator sensitivity. The letter "E" will be displayed over the artificial horizon if the elevator sensitivity is high, and the "E" will be absent when the elevator sensitivity is normal.

Flaps

The F key toggles the flaps. The letter "F" will be displayed over the artificial horizon when the flaps are active (down), and the letter "F" will be absent when the flaps are not active (up). When the flaps are active, their drag greatly reduces the speed attainable by SPITFIRE SIMULATOR.

Aileron-Rudder Coupling

When you are in the air, the X key toggles the cross coupling between the ailerons and the rudder. The letter "X" will be displayed over the artificial horizon when this coupling is in effect. There is no rudder action when the aileron-rudder coupling is not in effect; then only the ailerons are effective.

Level the Wings

The L key will level the wings when you are in the air. This command is useful when making a landing approach, overcoming an inherent difficulty with SPITFIRE SIMULATOR in making the wings exactly level with the aileron control.

Simulator Controls

Begin:

CTRL-B This command signals the computer that you want to begin pursuing targets. A target will be selected randomly. If you are viewing scenery, this scenery will disappear except for the horizon.

Initialize:

CTRL-I This command initializes the simulation. It may be used at any time, and results in a completely fresh start. It may be necessary to press CTRL-I several times to zero the compass heading.

Pause:

CTRL-P This command causes the simulation to pause, and is useful if you want to take a break. Pressing CTRL-C will continue the simulation.

Score:

CTRL-S This command shows you the number of targets you have destroyed during the current mission. You will receive a handsome bonus for each target destroyed if you return to the Aerodrome successfully. The computer also assigns you a rank based on the number of targets you've destroyed.

Transport:

CTRL-T This command transports the airplane to a new position. After giving this command, you will be shown your present coordinates and asked to specify the X,Y, and Z coordinates for the location you want to be transported to. Figure 1 is a map showing the X-Y coordinates of various points on the Grid scene. Z is altitude (1 unit = 200 ft). This command can always be used to determine your position, but the transport feature works only if you have fuel and are in the air.

Continue:

CTRL-C This command continues the simulation.

Scenery and Targets

There are two stationary scenes and eight moving targets for SPITFIRE SIMULATOR. The disk boots with Scene 0 displayed on the screen. The scene and target data is stored on the disk, and can be accessed by pressing the number keys as follows:

Number Key	Scene or Target Description
0.	This is the Aerodrome scene in southeastern England. The runway is aligned in the north-south direction, and you start out at the south end looking north. Before you to the left is the Headquarters building and its radio tower.
1.	Grid scene for general flying. It includes a north-south Training Field due north of the Aerodrome. There are some hills to the north. The Aerodrome is represented schematically. Figure 1 is a map of the Grid scene.
2.	Messerschmitt Bf 109 fighter (Me 109) target.
3.	Focke Wulf 190 fighter (Fw 190) target.
4.	Junkers Ju 87 B dive bomber (Stuka) target.
5.	Heinkel He 111 H6 bomber (He 111) target.
6.	Junkers Ju 52/3m trimotor transport target.
7.	Unidentified flying object (UFO) target.
8.	Zepplin dirigible target.
9.	Unidentified flying object (UFO) target.

New targets are selected randomly and automatically after a target is destroyed. Specific scenes can be selected at any time by pressing the appropriate number key.

AIRSIM-1 owners take note: SPITFIRE SIMULATOR can read the scenery data on the AIRSIM-1 Flight Simulator disk! If you own AIRSIM-1, you can fly a Spitfire around New England. To do this, simply remove the SPITFIRE SIMULATOR disk from the disk drive, and insert your

AIRSIM-1 Flight Simulator disk in the disk drive. The number keys will then give your SPITFIRE SIMULATOR access to the AIRSIM-1 scenery!

Crashes

Any impact with the ground with a downward-velocity indication greater than approximately 30 is a crash. There will be a great flash, crash sound, and a message announcing that you've crashed. Recover by pressing CTRL-C. You'll then be back to where you started after booting the disk.

3. A FIRST FLYING LESSON

SPITFIRE SIMULATOR is a complicated program with lots of options. We think that the best way to learn is by doing. In this section we're going to describe a sort of fooling-around exercise which we think will quickly get you familiar with the essentials of SPITFIRE SIMULATOR. At all times, remember to relax and enjoy yourself. If you crash - so what? All you'll have to do is press CTRL-C and you're back in business!

Getting Started

Boot your SPITFIRE SIMULATOR disk as described in Section 2. Some instrumentation and scenery will now appear. Imagine that you're sitting in the cockpit of a Spitfire fighter plane, looking forward out of the windshield. Ahead you'll see the runway with the Headquarters building and the radio tower on the left. The runway view is in perspective from close to the ground, so you won't be able to see the runway very well until you are in the air. Press the R key (R is for radar). The scenery will be replaced by a radar map showing your plane and the Aerodrome. You can control the scale of the radar view. Press the + key (or ; key)and the radar scale will start increasing in 2:1 steps. To halt the scale-changing process, press any key. You'll see a map of the Aerodrome. Press the 1 key to read the Grid scene off the disk. If you can't see anything after the disk stops, press the + key again until you can, and then press any key to stop the scale-changing process. You should now see a map of the Grid. You'll see how the Aerodrome is represented schematically in the Grid scene. Press the @ key (or the P key) to initialize the radar scale. Press the 0 key to load the Aerodrome scene again. Play with the + and - keys to see how the radar scale changes. To see scenery again, press the S key.

Try advancing the throttle to taxi around a bit. To increase the throttle, press the → (right-arrow key). You'll see THROT gradually increase. The speed (VEL) will also gradually increase. To stop the throttle from increasing, press any key other than the → key. To decrease the throttle, press the ← key, and to stop it from decreasing press any other key than the ← key. You can get full throttle (100%) in one step if THROT is 0 by pressing the / key. Similarly, pressing the/ key again will give zero throttle in one step.

Go to zero throttle and press the brake, the period (.) key to stop the airplane. Advance the throttle to 9%. This will allow you to build up some speed but not enough to take off. Note that hitting the brake (.) still brakes the airplane. Pressing any other key releases the brake. Try the aileron/rudder control (Paddle No. 1). Try taxiing the airplane around using the aileron/rudder control to steer the airplane. Cut the throttle to zero and use the brakes to stop the airplane. You'll find that the aileron/rudder control still turns the airplane even when the airplane is not moving.

As you use the aileron/rudder control, observe the AIL IND reading on the instrument panel. The AIL IND reading indicates the aileron/rudder setting. Adjust the aileron/rudder setting until the AIL IND reading is zero. You should be able to observe that there is a small dead-band region in the aileron/rudder control near this zero. You will want the aileron/rudder setting to be near the center of this dead band when you are flying. Otherwise you are likely to get a sudden unwanted change in aileron setting while you are flying, and this may upset a landing approach.

SPITFIRE SIMULATOR gives you control of the aileron/rudder sensitivity, the elevator sensitivity, and the coupling between the ailerons and rudder. Press the A key, and watch the screen above the artificial horizon; the letter "A" will appear and disappear as you press the A key repeatedly. The aileron/rudder sensitivity is normal when the "A" is absent, and high when the "A" is present. Now similarly, try the E key and look for the "E" above the artificial horizon. When the "E" is absent, the elevator sensitivity is normal; when the "E" is present, the elevator sensitivity is high. We recommend use of normal sensitivity until you've become proficient at flying SPITFIRE SIMULATOR. The flaps are controlled by the F key. Try the F key and look for the "F" above the artificial horizon. When the "F" is present, the flaps are active (down), and when the "F" is absent the flaps are inactive (up). In Section 4 we will discuss the use of the X key which controls the cross-coupling option for the ailerons and rudder. This option is effective only in the air. The aileron/rudder control effects only the rudder when the airplane is on the ground.

A Takeoff

Use CTRL-I to get the airplane positioned at the south end of the Aerodrome with the airplane headed north (COMPASS=0), ready for a takeoff. Alternately, you can taxi the airplane into position. Set the ailerons and elevator to normal sensitivity (no "A" or "E" on the screen) and have the flaps up (no "F" on screen). Apply full throttle (/ key) and watch the plane gather speed. Apply full up elevator. When the airplane reaches about 140 to 150 mph, you'll lift off the ground. The plane may bounce before finally lifting off; some up trim may help if that happens. Adjust the elevators so that you are climbing with the horizon just barely in view. Switch to Scene No. 1 now (press the 1 key). When you reach an altitude of 1000 ft, reduce the amount of up elevator to level the plane off gradually, and at the same time reduce the throttle setting to 49%. Doing this, we usually end up leveled off at an altitude of about 1500 ft with an airspeed of about 260 mph. You took off!

Level Flight

After taking off as described above, use the elevator to cruise in a due-north direction in level flight with the throttle at 49%. Your airspeed should be approximately 260 mph and your altitude should be about 1500 ft. Practice making small adjustments to the elevator, and see if you can maintain level flight. Please don't overcontrol the airplane! Apply a little up elevator and hold that elevator position constant while you observe how the airplane is going to respond. If this response is not what you wanted, make another small change in elevator position and wait again to see what the response is. Learning how to fly involves developing an intuitive feeling for how the airplane is going to respond. Once you've developed this intuition, you'll no longer need to wait after a control input, because you'll know from experience how the airplane is going to respond. It takes time to develop this feel for an airplane. That's a lot of what learning to fly is all about.

Climbing and Descending via Throttle Control

Once the elevator is adjusted for approximately level flight as described above, try increasing and decreasing the throttle setting. Increasing the throttle will cause the airplane speed to increase, and the airplane will start to climb. Conversely, decreasing the

throttle will cause the airplane speed to decrease, and the airplane will start to descend. There are thus two ways to control the altitude of an airplane - by means of the elevator and by means of the throttle. Experienced pilots know just what throttle settings to use to achieve a desired rate of descent when making a landing approach. You can learn that too for SPITFIRE SIMULATOR!

Viewing the Scenery

SPITFIRE SIMULATOR has two stationary scenes and eight moving targets. We'll postpone chasing the targets until after you've familiarized yourself with SPITFIRE SIMULATOR. For now we'll restrict ourselves to the two scenes, the Aerodrome (Scene 0) and the Grid (Scene 1). Takeoff and get into level flight as described above. If you've not already done so, press the 1 key. The disk will then read in the Grid scene. Figure 1 is a map of the Grid scene. We're going to use the transport command (CTRL-T) to take a little trip around the Grid. Press CTRL-T. You'll be shown your present map coordinates. Respond with X=0, Y=0 and Z=8. The airplane will suddenly jump to a new position, over the south end of the Aerodrome at an altitude of 1600 feet. Activate the radar with the R key, and you should see a schematic representation of the Aerodrome, with you being at the south end and moving north. It might be necessary for you to adjust the radar scale with the +, - or @ keys. If you really want to see yourself over the Aerodrome, simply load Scene 0 from the disk by pressing the 0 key. After you're satisfied, load the Grid scene (Scene 1) back in again by pressing the 1 key. Now we'll take a real computer trip. Get the scenery back again by pressing the S key. Now transport the airplane (CTRL-T) to X=-5000, Y=0 and Z=500. Wow! Look at that! (We assume you're flying level to the north as you were told.) That little postage-stamp looking thing up ahead is the Grid viewed from where we are now, far to the south, looking north. Try playing around on your own. Leave the airplane flying level and headed north, and transport yourself around. Use both Scenes 0 and 1, and use both the S and R keys, with the radar-scale changing commands, to get a feel for the flying space. Use Figure 1, and try to transport yourself to specific locations on that chart.

Turns in the Air

Let's try some turns in the air. Take off (unless you're already in the air!), climb to about 1500 ft with the throttle set to 49%, and adjust the elevator so that you are in level flight with an airspeed of approximately 260 mph. (The speedy stuff will come later!) Now let's make a gentle turn to the left. Rotate the aileron control counterclockwise about 20% of its clockwise-motion limit. (Move the joystick about 20% of its leftward-motion limit.) The horizon will appear to tilt clockwise as the airplane rolls counterclockwise, raising its right wing tip and dropping its left wing tip. The airplane is banking to the left. When the airplane has banked so that the horixon is tilted about 30 degrees, center the ailerons (AIL IND = 0). The bank angle will continue to increase momentarily due to the effects of roll momentum, but will soon stop. The airplane will also start to turn. Notice the TURN RATE reading. It should be negative indicating that we are turning to the left (smaller compass headings). However, keep an eye on your rate of climb and airspeed. The airplane is descending and the airspeed is increasing! Unless we do something, we'll enter into a spiral dive, and that we do not want! We want to make a level turn. We have to pull up the nose by applying some up elevator - not too much. Ideally, we want to coordinate the aileron and the elevator control movements so that the airplane maintains a constant altitude during the turn. Assuming all is going reasonably well for you in this turning process, watch the COMPASS. When your compass heading reaches due south, we'll show you some more computer magic. Ready? If so, level the wings by pressing the L key. Super wow! The wings went level instantly, and we're headed the way we wanted (well, nearly). Anybody can fly! If you feel that is cheating, you can try to come out of the turn the honest way. When you want to stop turning to the left, move the aileron controller to the right so that the airplane starts rolling to the right. When the wings are level (actually just before the wings are level) center the ailerons. It will take considerable practice before you can end up just where you want to be. It will also be necessary for you to reduce the amount of up elevator, or else the airplane will zoom upwards as you level the wings.

Airspeed Limitations

The Spitfire was a very fast airplane, and so is SPITFIRE SIMULATOR. There are no built in airspeed limitations for SPITFIRE SIMULATOR. The SPITFIRE SIMULATOR has a top speed in level flight of approximately 360 mph. It takes a long time to attain this speed if you are flying level, but you can reach it more quickly by putting the airplane into a shallow dive. The top speed in a dive is much greater than 360 mph. We'll let you find out what it is for yourself. You are also then liable to discover that there is a mathematical singularity in the coordinate transformations SPITFIRE uses when the climb angle (or the bank angle) is either plus or minus 90 degrees. This singularity does not affect the airplane itself, only the way the scenery is presented.

Well, now that we've gotten you up in the air, you might reasonably ask how you can get down to beloved terra firma again (the ground)! In Section 4 we'll discuss that and how you can even do aerobatics.

4. MORE-ADVANCED FLYING TECHNIQUES

In Section 3 we described how to take off, climb, descend, cruise at constant altitude, and turn. Here we'll discuss landings and aerobatics. You'll also find it useful to go to your local library and get out a few books about how to fly.

LANDING TECHNIQUES

Perhaps the most difficult maneuver to perform in SPITFIRE SIMULATOR is landing without crashing! The landing procedure is greatly simplified if the airplane is lined up with the runway so that it is not necessary to use the ailerons; then only the elevator and throttle need to be used. You can try landings in SPITFIRE SIMULATOR without having to use the ailerons at all! We've provided you with a Training Field straight ahead of the Aerodrome so that you can practice landings without having to make any turns. Let's try it!

Boot SPITFIRE SIMULATOR or initialize with CTRL-I to get yourself at the south end of the Aerodrome facing due north. Ahead of you is the Training Field on which you are going to attempt to land. Remember that you should not have to touch the ailerons, because no turns are necessary to reach the Training Field. If you are a beginner and do somehow manage to upset the airplane so that aileron control is necessary, you would probably be wise simply to initialize (CTRL-I) and start over again.

The Spot-on-the-Windshield Method

Take off from the Aerodrome, climb to around 1500 ft, and level off. Reduce the throttle to 49%. Load Scene 1, the Grid, by pressing the 1 key. You should see the Training Field straight ahead and below you. Activate the gunsight by pressing the G key. Now would be a good time to pause using the CTRL-P key while we discuss what you're going to do next. We're going to use what is called the "spot-on-the-windshield method" to make our approach to the Training Field. The basic idea of the method is simple. We want to set up our approach so that the airplane follows a straight line which starts where we are and ends at the nearest end of the runway we're approaching. Imagine a spot in the center of the windshield. If we fly so that this spot always lies on an object we're approaching, then we'll eventually fly the airplane right into that object. That's exactly

what we want to do, well almost exactly. We want to fly our airplane right into the nearest end of the runway, except that we want also to level off at the last moment to avoid a crash. That leveling-out process is called "flairing out".

We'll use an actual spot on the windshield, our gunsight. We'll fly level until the image of the bottom spot on the gunsight (one of the 6 spots surrounding the central spot) lies over the nearest end of the runway. It will be time to start our descent. We'll then drop the nose of the airplane and align the center spot in the gunsight with the nearest end of the runway. This will bring us properly to the runway, ready for the flairout and touch down.

The Descent

OK! Let's try it. (Press CTRL-C to continue.) Maintain level flight at 49% throttle at an altitude of approximately 1600 ft on a course of 0 degrees (north). Ahead you should see the Training Field approaching you gradually. When the nearest end of this field lies under the bottom spot on the gunsight, lower the flaps by pressing the F key. An "F" will appear on the screen if the flaps are active. Lowering the flaps will cause two things to happen. An increase in drag will slow the airplane down, and an increase in lift will cause the airplane to rise momentarily. Use the elevator control to lower the nose of the airplane gradually so that the central spot in the gunsight is aligned with the image of the nearest end of the Training Field. Leave the throttle at 49%. You'll need that power to pull the airplane along with the greatly increased drag due to the flaps (and landing gear which we'll assume is lowered when the flaps are lowered!). The CLIMB RATE should indicate approximately -50 during this descent. Try to make a nice steady descent right to the nearest end of the runway - keep it right on that center gunsight spot. If you get too messed up, you can always raise the flaps (F key) and use CTRL-T to transport yourself back to near X=90, Y=0 and Z=8, which is a good location for making another attempt. Alternatively, you can initialize using CTRL-I, thus starting all over again from the Aerodrome.

The Flairout and the Touchdown

Let's assume you've descended to an altitude of about 200 ft and the runway is zooming up fast. Now we want to "flair out" to settle

down to the ground. Gradually give up elevator to pull up the plane's nose. Adjust the elevator gradually - don't overdo it! Try to attain and keep a descent velocity between 15 and 25 (CLIMB RATE -15 to -25). Don't move the elevator too far or you'll zoom up and perhaps even stall, far off the ground. You want to let the airplane settle gently onto the runway. Your airspeed should gradually decrease. When your altitude gets to about 10 or 15 ft, cut the throttle with the / key. Try then to hold the airplane just off the ground as long as possible by giving more and more up elevator. Don't worry about running out of runway. The Training Field is very long. If you're successful, you'll settle gently onto the runway with an airspeed of less than 140 mph without a bounce. If you do bounce, don't overcontrol the elevator. Make small control motions and wait to see how the airplane is going to respond. Once you're on the ground, apply the brakes. The airplane will then quickly come to rest. You can use the radar (R key) to see where you ended up.

If you land successfully at the Training Field, you can, if you want, just turn your airplane around on the runway until it is facing due south (COMPASS 180), take off, and try to land at the Aerodrome. The landing procedure is unchanged. Alternatively, you can initialize using CTRL-I.

Advanced Landing Techniques

It is one thing to make a successful landing on the Training Field after taking off from the Aerodrome when you've left the ailerons alone so that you remain lined up with the Training Field. What do you do if you've been brave enough to fiddle with the ailerons? We've tried to address that problem in SPITFIRE SIMULATOR. We've provided a bit of computer magic called the L command which levels the wings instantly when activated by pressing the L key.

Imagine you are flying west (COMPASS 270) and want to land at the Aerodrome. Bank to the right so that the airplane turns north. When you are headed north (COMPASS 0), center the ailerons and press the L key. Your wings will become level in one step! If your course is not exactly correct, turn again but more gently this time, and when your course is right press the L key again. As you gain experience, you'll be able to attain leveled wings and the desired course in one step. Once you are on the right course, heading for

your landing approach, you can use the CTRL-T command to transport yourself to the right position for a landing approach. If you think that is cheating, you always have the option of doing it honestly! We just gave you the options; it is for you to decide what you want to do! After you become proficient at flying, you'll probably want to use the "L" command just to overcome the difficulty inherent in SPITFIRE SIMULATOR in making the wings exactly level when they are just a little off being level. That's not cheating!

Coupled Ailerons and Rudder

When you are in the air, you have the option of having either aileron control without any rudder action, or aileron control with coupled rudder action. This cross-coupling is toggled by the X key. When this option is active, an "X" will appear on the screen above the Artificial Horizon.

You'll have to gain some experience with SPITFIRE SIMULATOR to decide how you want to use this option. We'll describe two situations illustrating how we use it. If we're flying with the wings level and want to initiate a roll without initiating a turn, we want ailerons only, with no rudder action (X command not active). If we are in a turn and want to roll out of the turn without turning any further, then we want aileron-rudder coupling (X command active). The effects of the command are subtle but useful.

AEROBATICS

There are a few aerobatic maneuvers that are easy to do, and a lot of fun. Here the advantage of a computer airplane over a real one becomes very apparent, especially if you get airsick! SPITFIRE SIMULATOR offers a further advantage over the Spitfire Mk 1, which could not fly inverted due to its float-bowl type carburator.

The Loop

Our favorite aerobatic maneuver is the loop. You won't need the ailerons at all if your airplane is flying with wings level and steady. Advance the throttle to 100% and climb to around 1000 ft or more. Once you are at altitude, go into a gentle descent, still at full throttle, and let the speed build up to 320 mph or more. Then gradually and steadily give more and more up elevator until the elevator is full up. Don't move the elevator too quickly,

especially if the elevator sensitivity is high (E key and letter "E" present) or you may get a high-speed stall.

With the elevator up, the ground will quickly disappear and all you'll see out of the windshield is sky. The airspeed will gradually decrease. Soon, however, you should see the horizon appear again as you pass over the top of the loop. You are now upside down, hanging in your seatbelt harness. You should soon be able to see the ground above you. Your airspeed should now gradually increase. Continue to hold full up elevator. If you're above a runway, you'll see the ground rush up to meet you as you dive down, and then pass under you as you level out. As you do level out, bring the elevator back to near its central position and maintain level flight. You just made a loop.

Outside Loop

Outside loops are easy too. Use the CTRL-T command to transport yourself to an altitude of 20000 ft above the Aerodrome (X=0, Y=0 and Z=100). Set the elevator to high sensitivity (E key). Gradually apply full down elevator. The plane will nose over, dive down, and gradually go upside down so that you can see the ground above you. When you reach the bottom of the loop, continue to hold the full down elevator, and wait for the airplane to complete its outside loop by climbing up until you can see the horizon with the ground now below you again. That was the dreaded outside loop.

Inverted Flight

Now try inverted flight. There are two ways you can achieve this. You've already done one; do half a loop. When you see the horizon with the ground above you, apply down elevator (yes, down elevator!) to make the airplane maintain level flight. Once you've got the airplane inverted and maintaining approximately level flight, try flying around in inverted flight. You'll find that SPITFIRE SIMULATOR does not fly anywhere near as well inverted as it does right-side up! There are two ways to right the inverted airplane. You can do a half loop, or you can roll right-side up.

Rolls

The other way to get inverted is by doing a roll. We'll illustrate by doing a roll to the right. Get the airplane into level flight at

49% throttle. Apply full right aileron (rotate the aileron controller fully clockwise). The horizon will start to rotate counterclockwise as the plane rolls clockwise. When the horizon has rotated about 45 degrees, get ready to stop the rolling motion by bringing the ailerons back to center, or even a bit beyond center. In this way stop the rolling motion and keep the wings level with the airplane upside down. Simultaneously, apply some down elevator to hold the nose up as the plane rolls over upside down.

SPITFIRE SIMULATOR does very nice rolls. We'll illustrate again with a roll to the left. Get the airplane into level flight at full throttle (Here comes some fast stuff!). As the airplane rolls counterclockwise, the horizon will appear to rotate clockwise. The tricky part of rolling concerns what you do with the elevator. When the airplane is upside-down, you'll have to apply down elevator to keep the nose of the airplane up! So, as the airplane rolls from being right-side up to being upside down, you want to move the elevator gradually from being up to being down. Also, as the airplane completes rolling from being upside down to being right-side up, you want to move the elevator gradually from being down to being up! Experienced pilots coordinate the elevator position with the roll position so that the airplane closely maintains level flight throughout the roll. It's a difficult maneuver to perform well, i.e., without large changes in altitude.

We recommend that you use normal aileron sensitivity at first for doing rolls. After you've got the idea at normal aileron sensitivity, try rolls with high aileron sensitivity (use the A key).

Stalls

It's important to become familiar with stalls when flying, because you may otherwise accidently stall the airplane and crash. It's possible to stall SPITFIRE SIMULATOR and recover. However, SPITFIRE SIMULATOR has a very heavy wing loading and thus behaves differently than does a light plane in a stall. SPITFIRE SIMULATOR needs more altitude to recover. To try a stall, get into level flight at 100% throttle at 2000 ft or more altitude. Use high elevator sensitivity (E key). When the speed has built up to more than 300 mph, cut the throttle (/ key) and climb at a moderate angle. The airspeed will gradually decrease. As it does so, continually apply more and more

up elevator so that the airplane maintains approximately a constant climb angle with the horizon just barely in view. The airspeed will keep dropping. Eventually the airplane will stall. There will be a beeping sound (the stall warning) and the nose will drop. Notice the speed at which the airplane stalled. We find that SPITFIRE stalls at about 100-115 mph in this experiment. When the airplane stalls, immediately apply full down elevator. After the nose drops, apply full throttle. As soon as the airspeed builds up to well above the stall speed, apply up elevator to pull the nose up into level flight. If your altitude was too low when you entered the stall, you will not have sufficient altitude to pull out, and guess what will happen to you then!

THE ARTIFICIAL HORIZON

The Artificial Horizon, shown in Figure 1, provides information about the attitude of the airplane. It tells whether the airplane is climbing or descending, and whether the wings are level or the airplane is banked. There are two elements in the Artificial Horizon. The first element is a small end-on view of an airplane which never moves and serves as a reference. The second element represents the horizon and the ground, and moves as the airplane climbs, dives and banks. The Artificial Horizon is an easy instrument to use. Figure 1 shows how the Artificial Horizon looks in a variety of situations. In interpreting the Artificial Horizon, imagine you are behind the airplane and looking forward along the centerline of the airplane toward the horizon. If the airplane symbol is above the horizon, the airplane is climbing. If the airplane symbol is below the horizon, the airplane is diving. If the airplane is banked, the horizon is rotated. The Artificial Horizon is especially useful when making turns.

MISCELLANEOUS FUN

We've had a lot of fun just flying SPITFIRE SIMULATOR around in a hell-bent-for-leather fashion. A flight simulator gives you a freedom to fool around that is not available when flying a real airplane. We'll describe below a few of the many miscellaneous possibilities that exist for enjoying SPITFIRE SIMULATION.

What we enjoy most, next to pursuing targets, is buzzing the Aerodrome. We love to swoop in on a fast low descent, passing low over

part of the field, especially the Headquarters and radio tower. That really infuriates the Wing Commander! We then bank sharply and fly out away from the Aerodrome, and do a sharp wingover turning us around ready to make another pass from another direction. The Aerodrome quickly goes out of view after a pass, but we've gotten really good at keeping it in our mind's eye so that we have no trouble bringing it back into view again. Inverted passes are particularly hair-raising.

Here is another hair-raising suggestion. See how fast you can fly from one end of the Aerodrome to the other (no CTRL-T!). Use the radar to tell when you've crossed one end of the field and when you've crossed the other end of the field (have a friend time you with a stop watch). The hair-raising aspect of this arises from the fact that the best way to get real speed is by diving the airplane! RULE: Your altitude is not to exceed 500 ft at any time during the timed portion of your pass. If that gets dull, try it inverted!

Here are several suggestions for those who enjoy an intellectual challenge. SPITFIRE SIMULATOR consumes its fuel as it flies, and the rate of fuel consumption depends on the throttle setting. This suggests endurance events. At least three types are possible. The first type involves flying a maximum possible distance. The second event involves flying the maximum possible time. The third type of event involves setting an an altitude record. RULE: Transporting yourself using CTRL-T is not allowed! Use CTRL-T only for determining your position. We look forward to hearing of some amazing records. WARNING: SPITFIRE SIMULATOR is very difficult to land after the fuel is expended!

5. PURSUING TARGETS

Here we get down to the crux of SPITFIRE SIMULATOR, the pursuit of moving target aircraft. You'll have to become a proficient flier before you'll have much success destroying targets, but we'll show you that even fairly novice fliers can experience the thrill of pursuing moving target aircraft using the facilities we've made available to you. If you've ever seen gun-camera pictures taken by a fighter plane in pursuit of another aircraft, then you'll find what you'll see in your Apple to be very similar to those pictures.

Selecting Targets

There are eight different types of targets available for you to pursue as described in Section 2. You have two options for beginning to pursue targets. You can select any specific target at any time simply by pressing the number key appropriate for that target (2 key to select the Me 109, 3 key to select the Fw 190, etc.). Alternatively, you can begin target pursuit by pressing CTRL-B. Then the computer will randomly select a target for you to pursue. This CTRL-B mode is a more realistic simulation of the situation which confronted the Spitfire pilots during the Battle of Britain.

Determining Target Course

When a target is present, a message will appear at the bottom of the screen saying "TARGET X,Y,Z = ", reporting the target position. You can use this information for finding the target. Observe the target X,Y, and Z coordinates for the target. Since the target is moving, these coordinates will be changing as time passes. All the targets fly either on north-south (south-north) courses or on east-west (west-east) courses. You can determine the target direction by observing whether the target X coordinate, or the target Y coordinate is varying, and in which way it is varying. For example, if X is increasing, the target is headed north (COMPASS 0 or 360), and if X is decreasing the target is headed south (COMPASS 180). Of course, the Spitfire pilots did not have this nice target information. They had to locate their targets visually, with the assistance of radar information supplied to them by ground controllers. You can locate targets that way too if you wish! You have radar, and you can see the targets if they are in your field of view. We've just given you lots of options.

Intercepting a Target

Once you've determined the direction a target is headed, you have two options. You can either try to fly a course to intercept the target, or you can use computer magic, the CTRL-T command, to transport yourself to an appropriate position to intercept the target. It is much more difficult to fly your plane into position than it is to use the CTRL-T command. In fact, it may occasionally be impossible for you to intercept a target simply by flying your plane to intercept it. Such would be the case with a fast target (Me 109, for example), far off, and headed away from you. Your fuel would be expended before you could intercept such a target.

We find plenty of challenge even in using the CTRL-T command to aid in target pursuit. We'll illustrate the procedure here. Imagine, for example, that you are headed south (COMPASS 180), and the target is reported as follows: TARGET X,Y,Z, = 45, -30, 19. Assume Y is increasing (heading positive, i.e., Y = -30, -29, -28, etc.). The target is headed west. Turn your airplane to the west (COMPASS 270) by turning to the right. You can use the level command (L key) as an aid in coming out of the turn if you wish. Now use the CTRL-T command to transport yourself to X=45, Y=-40 and Z=20. Notice that we had you position yourself well behind the target and slightly above it so the target would not appear right on the horizon. The target should now appear suddenly before you.

Once the target is in view, you'll have to make an assessment of the target speed. You'll probably have to adjust the speed of your plane with the throttle. Some of the targets are so slow, the Zepplin for example, that it's impossible for you to fly at the target speed, even with the flaps down.

The radar (R key) is useful for determining the target position, especially when you are close to it. One of the difficult aspects of SPITFIRE SIMULATOR is that you have a narrow field of view covering only what is directly ahead. The Radar is then very useful.

Destroying a Target

If you have not done so already, activate the gunsight (G key). Also, as an experiment, fire the machine guns by pressing either of the game-paddle pushbottons. There will be a machine-gun like sound, and

tracers will streak out from the wings and then disappear. The tracer graphics erase any dots on the screen that they pass over. If they pass over the image of a target, they will erase that part of the target image. This does not mean that they hit the target. If a target is destroyed, you will see an explosion issue from the target, and the target will disappear. Simultaneously, a small airplane symbol will appear in the upper right-hand corner of the screen to indicate that a target was destroyed. Also the disk drive will automatically read in data for the next, the target type being selected randomly by the computer. If you press CTRL-S, you'll see your score, showing the number of targets you've destroyed on this mission and your rank. SPITFIRE SIMULATOR can record up to 30 targets destroyed on the screen, but CTRL-S can indicate up to 255 hits! We doubt very much that anyone will ever destroy even 30 targets on one mission!

When a target is destroyed, a new target is selected randomly by the computer. However, you also always have complete control over the type of target available for you to pursue. To select a specific type of target at any time, simply press the number key appropriate for that target type as described in Section 2.

Bonus for Successful Mission Completion

Your mission is not completed successfully until you have landed at your Aerodrome. You'll have to keep an eye on your fuel, because the magical CTRL-T command will transport you only so long as you do have fuel! You probably will want to use this command to assist you in your landing approach, so don't use up all your fuel chasing targets. Of course, if you are a purist, you can fly all the way without the aid of the CTRL-T command. The option is yours. You can also glide after your fuel is gone, but the Spitfire was not designed as a glider! If you do succeed in landing after destroying one or more targets, you will receive a handsome bonus.

SUMMARY OF COMMANDS

Push Buttons - Fire machine guns.

Paddle 0 - Elevator, counterclockwise up.

Paddle 1 - Aileron/rudder, clockwise right.

/ key - Toggle throttle.

→ key - Increase throttle gradually.

← key - Decrease throttle gradually.

. key - Brake.

A key - Toggle aileron sensitivity.

E key - Toggle elevator sensitivity.

F key - Toggle flaps.

G key - Toggle gunsight.

L key - Level the wings.

R key - Radar

S key - Scenery.

X key - Toggle aileron-rudder coupling.

@ key - Initialize radar scale.

+ key - Increase radar scale gradually.

- key - Decrease radar scale gradually.

CTRL-B - Begin pursuit of targets.

CTRL-C - Continue the simulation.

CTRL-I - Initialize the simulation.

CTRL-P - Pause in the simulation.

CTRL-S - Score for targets destroyed.

CTRL-T - Transport the airplane.

0-9 keys - Select scenes or targets.